KEK Visit Daily Log (Feb 12-Mar 04, 2007)

Rama R. Calaga

- **Feb 13, 2007 (Tuesday)**:

  Meet Oide San & Ohmi San ∼8:30 am and commissioning meeting at 9am. Beam operations starts today with first commissioning using low current beam in both HER/LER ∼30 mA.

  HER crab cavity commissioning was well and phase stability between cavity-klystron ±3°. However, LER cavity phase ±30°. Tuning mechanism using the TM_{010} coax coupler, very complicated scheme. There was a change in the support for one of the tuning plates to make it stronger but this made the phase stability go from ± 12°to ± 30°. Observed some bulging of the support screws. They will modify the support back to horizontal test condition with some special c-clamps. After a few modifications and re-arrangement through the afternoon, they managed to stabilize the phase back to ± 15°.

  Crab cavity detuned and zero field for injecting and tuning beam. 30 mA injected into both HER/LER and beam conditioning. Followed by optics correction (response matrix using quads), coupling correction (symmetric sextupole bumps), dispersion correction (antisymmetric bumps) for both rings to a few % level. Correction takes approx 2-3 hrs for both rings usually done every two weeks due to drift in optics functions. Coupling and dispersion are usually ok.
  *Plots from Oide San

  Oide San mentioned that there are 450 button type BPMs in each ring. Only about 30 bpms that can take TBT data, so they use the avg. orbit + response matrix for optics correction. Very effective and robust. The four buttons are independent measurements, so they have a technique to map BPM gain using different combinations of the voltage readings and beam position (Sato San). Fit to model to observe the gain changes (ex: connector movements etc...). Can we implement this for LHC and RHIC (for double plane bpms) ?

  Way to jet lagged and trying to adjust to the food...

- **Feb 14, 2007 (Wednesday)**:

  Commissioning meeting at 9am, discussion about previous night crab cavity improvement and beam tuning (off course everything in Japanese). No beam till 5pm. They are going to condition the cavities to nominal voltage (1.4 MV or higher) in situ until evening. Will go to the crab RF bldg. to watch.

  Conditioning began approx 10:10am. Around 11:30am trip in LER cavity, check interlock and back in business. LER cavity power increment somewhat faster. 11:45 am LER: 1MV and HER: 0.77 MV. Vacuum in

the cavities $< 10^{-7}$.
*Plots from Oide San

Some discussion with Akai San about the KEK crab cavity. The rectangular profile was first developed in 1992. Numerical codes not very efficient at that time, so not much difference between elliptical or rectangular profile. No multipacting type process observed due to flat walls transversely. Main multipacting in coax coupler for TM_{010} damping. But at low fields which can be processed through (perhaps cavity multipacting at low fields as well). $Q_{ext} < 100$ is expected from coax damping.

Akai San said that the piezo load as a function of coax penetration from the sensor placed behind the piezo is linear and behaves ok. However, the frequency response as a function of coax penetration is puzzling. There seems to be threshold near nominal frequency (f_0) beyond which, the frequency changes sign instead of continuing to increase. Appears like coupling of some mechanical modes which may be the reason. Thus the large fluctuation of phase for the LER cavity. The low level RF is expected to have a gain of about 100, therefore the relative phase deviation w.r.t to the beam will be to spec ($\sim 0.3^\circ$).
* Plots from Akai San

More conditioning in the afternoon but increase in gradient is very slow. The maximum kick voltage reached during the afternoon was $\sim$ 1MV (1.4MV needed).

Beam in both rings 30 bunches, 30 mA. There was discussion about larger current but due to safety for the crab cavity, measurements will be done at 30 mA.

Horizontal and vertical orbits were varied in the crab cavity and output power and vacuum pressure were monitored as a function of orbit offset in the crab cavity to determine the beam center of the cavity. Vertically, difficult to observe since there is no mode (ideally). The measurements show 2 mm and 4mm offset for the beam center in the cavities. Most likely due to FPC asymmetry in the cavity.

Since, some discrepancies were noticed in BPM gains, BPM gain mapping was performed using horizontal and vertical kickers (2 per plane each separated by $\pi/2$). The orbit was excited in a diamond pattern and .... Quad BPM method using varying quad strength close to the crab cavity as a function of the orbit through the quadrupole was measured to determine the center of the quad.

- **Feb 15, 2007 (Thursday)**: 9am meeting, main discussion about crab conditioning and increase in beam current. RF people feel that the RF shield or some unknown effect in the crab section can damage the cavity due to high current. They prefer to have collisions at 30 mA to be on the safe side. However, Oide San and some others wants to go to higher beam current soon with detuned crab cavity so it is conditioned

both with RF and beam. And then apply collisions with crab crossing to avoid any strong discharge with beam+cavity on.

Meeting with Ohmi: He believes that the emittance tolerances from his code due to RF phase noise is realistic but the model is very simplistic. He is very busy with J-PARC and KEKB, so I will acquire his code to start some simulations. He agreed to help me start-up his code (however not parallel). He mentioned that the emittance growth from weak-strong and strong-strong simulations are quite similar even though the mechanism for emittance growth is quite different. Perhaps we should benchmark with HEADTAIL and some version of MADX if it ever becomes a reality. Things to include: Sector map from LHC lattice, 2 IPs and others.

There seems to be a problem with the temperature of the coax due to some change in the Helium flow rate. They observe an increase in the sensor, will check tomorrow in the tunnel.

Beam at around 6pm and Oide San and Koiso San managed to inject upto 60mA, but low charge into both rings with decent lifetime. The main goal is to do calibration of streak camera. There was a problem with the septum magnet around 9pm, and was fixed for further studies. Some vacuum scrubbing tomorrow morning.

- **Feb 16, 2007 (Friday)**:

  Meeting at 9am as usual. Discussion about higher beam current (60mA), streak camera calibration and RF conditioning. Akai San's group presented that both cavities reached 1.4 MV design kick voltage but they want to go as high as 1.6 MV for some margin. Condition today and perhaps through the weekend to achieve this since Oide San wants to try beam with crab cavities early next week.

  Small meeting of Akai San and they went to the tunnel to check on heating of the coax coupler due to helium flow change. 11:20 am they start RF conditioning again. with HER at 1 MV and LER at 1.3-1.4 MV. Akai San mentioned that they have several interlock systems to turn of RF in case of sudden increase of vacuum pressure or temperature. The power from the coax is rejected at 500 MHz due to the notch filter and the rest goes to ferrite. He estimated a few hundred watts from the broadband impedance. Since their bunch length is small (6mm), the loss factor from TM_{010} is not so dominant even though R/Q is large. He estimated about 10% and the rest from high frequency.

- **Feb 19, 2007 (Monday)**:

  During Sat. more RF conditioning yielded only marginal increase in the kick voltage. They were able to reach 1.45 MV (HER) & 1.51 MV (LER). Morita San mentioned that they were able to reach $\sim$1.8 MV during the vertical testing. The plan is to condition more Monday morning and try beam with cavities on in the evening.

During Sunday they tried upto 80mA (cavities detuned), and did optics correction, orbit feedback, tune scan and luminosity tuning. They have some "tuning knobs" (coupling, dispersion,...) to tune for best luminosity and lifetime. The luminosity ratio to the best performance is $\sim$50%, but it is probably hard to tune with such low currents.

Yamamoto San gave an overview presentation about the RF conditioning and other RF experiments from last week. RF conditioning begins again. The LER cavity is around 1.5 MV and input coupler trips. For the HER cavity, the input coupler also trips around 1.45 MV, so Morita San is trying pulsed conditioning to see if we can get past. Typically stay $\sim$5 mins at given voltage with pulsed RF and try to increase. Withe pulsed mode, the HER cavity was able to go close to 1.6 MV. Vacuum trips after this, so repeat this another time.

Some more conditioning during the afternoon and both cavities reached closed to 1.6 MV (HER is a little less). They will try to use low current beam with a smaller kick voltage than nominal to be make sure they don't quench the cavity with beam on. Infact the conditioning is done without feedback to avoid damaging klystron from repeated quenches.

6pm, and beam is injected into HER. The sign of the RF curvature is not known, so they calculated the orbit deviation due to phase offset in model. The crab kick is calculated from a the orbit deviation and the phase is scanned 2π to determine the zero crossing of $\vec{B}$ field and the slope. They need to sit on the negative slope to get the kick in the right direction. At 6:50pm, the HER scan is finished and the crab kick from the orbit yields a nice sine curve. Now tuning the LER in a similar fashion. The sine curve was reproduced for LER as well. A higher voltage scan HER (1.4MV) & LER (1.2MV) to do another scan for cross check with higher voltage.

Now they will inject single bunch for more so they can see the sync light in the streak camera to observe the bunch tilt. The phase was changed by π in the HER and the opposite tilt angles was observed (hurray!!). LER seems to have some problem with streak camera, taking a look. Both beams crabbed successfully, but luminosity w/o crab cavities is not still optimal. So they will detune the crab cavities to optimize luminosity before collisions with cavities.

- **Feb 20, 2007 (Tuesday)**: During the overnight shift optimization of dispersion (mainly) and other tuning parameters at the IP brought the luminosity close 100%. During 9am meeting the results from the crab deflection were discussed. Morita San mentioned that they were able to close the feedback loop for both the rings and keep the phase fluctuation below 0.5°(plots from Yamamoto San). They observed some degrading of voltage in the LER and thus kept the voltage to 1 MV in the LER during the crab experiments. Koiso San will try to optimize the beta function at

the LER crab cavity to compensate for the lower voltage to acheive the same tilt as at 1.4 MV nominal.

In the phase voltage sine curve, the x-axis (phase) is not exactly calibrated, so there is small discrepancy in the the amplitude at 0°and 360°. The plan is to continue more RF conditioning this morning to be able to go to a higher crab voltage in LER/HER. Then try to inject higher current into both rings (30mA, 30 bunches) and optimize for luminosity and lifetime during the evening shift.

10:30am and back to RF conditioning. Approx 1.4 MV (HER) and 1.25 MV (LER). The HER is kept stable at 1.4 MV and the conditioning continues in the LER. It appears like the coax pressure and temp are pretty high. Even the pulse mode seems to trip the pressure at 1.2 MV probably due to multipacting at the coax coupler. Feel that maybe there is a some otugasing from the ferrite (CO or Hyrdogen) causing this pressure rise.

After lunch the conditioning continued and the LER was stable upto $\sim$1.3 MV. The plan is to inject 30mA (LER) and 15 mA (HER) to get an approx. ratio of the energies. This is needed to keep the blow up of the LER beam to a minimum. Tje crab cavities are set to 1.2/1.4 LER/HER and collision tuning will be done. A new optics with increase the β_{crab} from 40 to 74 m to compensate for the lower voltage in the LER.

5:30pm injection to LER/HER and application of new optics. Lost beam in LER because of some large orbit oscillation. Apparently there is some location where the a local bump is used because of a beam pipe problem. The new optics made the bump unclosed and hence an aperture problem. Fixed the bump and now correcting optics. They use sextupoles to correct both η_y and x/y coupling using asymmetric bump because of the sextupole arrangement with $-i$ transform. They use about 12 kicker and a few iterations to get convergence. Next they correct beat-beat (similar response matrix techniques) with the quad circuits.

- **Feb 21, 2007 (Wednesday)**:

  9am meeting. The main focus of the late night shift was to tune for luminosity after the optics corrections using the IR knobs. A change in the R_{12} seemed to help the luminosity which is close to the best record some years ago (they do this very frequently and usually are above this level). Last night around 10pm the $\beta_{crab/IP}$ increase caused a trip due to some part of the beam touching the cavity. Not catastrophic but they have to watch out not to destroy the cavity. Koiso San mentioned that the β_{crab} has been reduced slightly during the tuning and the design 1.4 MV is not sufficient to zero the crossing angle. They now need close to 1.56 MV with the current optics. This morning, they will constrain the β_{crab} to original level and re-match optics in HER while LER will undergo some more RF conditioning.

  HER with 30mA and the β_{crab} and β_{IP} are changed for 1.4 MV. Beam aborted due perhaps due to bad working point, but will reconfigure and

startup again. After prbit correction, coupling, dispersion and beta-beat the HER looks looks good. The LER will stop conditioning for reinjection of beam and correction of optics. While injection to LER (2 Hz), the crab cavity tripped probably due to vacuum. Will rinject again.

HER$\sim$14 mA & LER$\sim$28 mA. They are moving the HER horizontal offset at the IP as a function of luminosity. Observed a steep loss at some point, so retracted. Ohmi San mentioned that they usually see an asymmetry in the beam lifetime with the presence of crossing angle as they scan the horizontal offset, reason not completely understood. Scan the horizontal offset to find the optimum vertical beam size, Then feedback on this position to keep the veritcal beam size stable. But it appears that this asymmetry is reduced significantly or gone once the crossing angle was removed. Now they can feedback on the horizontal orbit instead of vertical beam size blowup.

Akai San is doing a voltage scan of the crab cavities to find the optimum luminosity and then they will repeat the offset scan, coupling, dispersion, etc.. at the IP. Hopefully they will reach beyond 135% which was the highest with crossing angles.

- **Feb 22, 2007 (Thursday)**:

  During the overnight shift they scanned the voltage HER (1.2-1.3 MV) and LER (1.1-1.2 MV). Some more orbit tuning, IP tuning and they managed to get $\sim$116% of the luminosity. Perhaps the first collisions with crab cavities and decent luminosity. It appears like the HER beam is like a "weak beam" due to the increase in β^* in the HER. Usual 9am meeting and Yamamoto San presented some results from the cavity side and compared the voltage performace over the last few days with and w/o beam. The trend clearly shows some degradation of gradient esp. in the LER ring, therefore the lower voltage to prevent any trips. The phase stability of the crab RF seems a bit larger with beam than w/o (plots from Yamamoto San).

  This morning is maintainence, nothing big but a few small fixes. I managed to slip in with a group that went sweeping the tunnel and got some nice pics of the ring and the crab cavity section. After 5pm, they will try to inject beam with increase β^* for the LER to increase the beam lifetime of the HER beam. Then try crabbing the beam again.

  Injected beam and collision tuning for tonight. Will try to finish my talk for tomorrow.

- **Feb 23, 2007 (Friday)**:

  This morning meeting, results from collision tuning was presented. They had a couple of trips from the crab cavity but nothing serious. Akai San setup an automatic RF recovery system so they don't use up too much time to restart RF. He gave some explanation of this system but in Japanese, so I need some translation from him.

My seminar went well and some interesting questions. Oide San asked about the tune shift part for the 1σ particle and pointed out that it looks linear. So, we can probably use some arrangement of sextupoles to correct this tune shift if it is a limitation. He was also very interested in the exotic TM_{010} cavity and felt that we can simply damp the HOMs and may make the cavity much simpler than the conventional TM_{110} cavity. Perhaps a prototype of such may be interesting. Oide San also mentioned that Yamamoto San may visit CERN in the near future and may want to join the crab cavity effort. Will need to ask him if he would interested in couplers/low level RF for the crab system.

Akai San asked a question about damping the 0-mode of the 2 cell structure since we will use the π mode for deflection. I replied saying that if the separation is not sufficient, we can make a 2-cell cavity with a beam pipe of $\lambda/2$ inbetween, so we can use the 0-mode to deflect and hence the π-mode will be higher frequency. However, have to look at the R/Q for this.

Todays plan is simply inject higher current in both rings (30mA) and 30 bunches and perform collision tuning. The general idea to increase bunch current to some comfortable level and stable operation and establish a good luminosity ratio. They believe that they can see the beam-beam tune shift due to head-on with this bunch current (relatively low compared to their nominal operations $\sim$1-2 Amps).

- **Feb 26, 2007 (Monday)**: During the weekend, tuning of the IP knobs continued. From a brief discussion with Ohmi, the beam-beam kick knob scan yielded an almost sine wave, therefore they can tell if they are colliding head-on. However, the luminosity and lifetime are a bit worse when the collisions are head-on and they see a better performance when the beams are slightly offset horizontally. Some simulations are needed to verify this but Ohmi thinks that this maybe due to large beam-beam tune shift. I don't quite follow his reasoning so I need a second round of discussion with him.

  Today's plan is to continue the tuning of IP dispersion, offset, and coupling. Perhaps they will reduce the beam current and/or cavity voltage during the scan to compare the effects observed during the weekend. Starting tomorrow, they will try to increase the beam current and take it upto 300 mA. Maybe some cavity conditioning is necessary before this increase.

  At lower current there was no siginificant improvement of the situation. The head-on using the beam-beam kick orbit is not maximum of the luminosity. I proposed Ohmi San to change increase the vertical tune. Also, the voltage scan (effectively changing the crossing angle) did not show any significant change in luminosity or lifetime. From Ohmi's San simulation it appears like the higher tune yields a more dramatic effect on the crossing angle. The LER vertical tune was increased from

$\sim 0.505 \rightarrow 0.58$ which is close to the HER vertical tune and horizontal offset scan was performed. This time maximum of the luminosity is close to the zero BB kick orbit. The new vertical tune seems to be a better working point. They will optimize the optics, dispersion and IP offset at this new working point. I proposed to do a tune scan to further increase lifetime and Ohmi San said we can perhaps try this tomorrow. Now they do the regular luminosity tuning using IP knobs for the rest of the night.

- **Feb 27, 2007 (Tuesday)**:

  9am meeting and discussion about the previous evening's tune change. Ohmi San showed some simulation of the beam-beam tune shift contour plots for different working points. Right now both HER and LER tunes are almost similar but since it is low current, coherent modes don't seem to be a problem. Ohmi San and I requested to do a tune scan with 30 mA to find a better working point. Perhaps in the evening. They will check some crab RF stuff and vacuum monitor resets in the tunnel and start up. The idea is to increase the beam current $\sim$8mA/hr. Bunch current around 40 mA and some crab tuning under progress.

  Discussion with Akai San: He showed me a few details about the low level RF system. Based on beam loading in the crab cavity, they picked the $Q_{loaded} \sim 2 \times 10^5$ which requires about 50-100 kW input power with zero phase offset. Higher Q_{loaded} was avoided because the power requirement is low but sometimes may become unstable due to orbit offset and they cannot control the phase. Also, they have RF systems that can go upto 600kW, so power is not a problem and 10^5 is a safe area since it is less sensitive to orbit offsets. For coupled bunch instabilities, they detune the cavity by a fee kHz but stay below the radiation damping to avoid instability. However, this detuning is very close to the operating frequency and for high current Akai San anticipates to detune beyond 100 kHz on the other side of the f_{rev} to be on the safe side. Also, the detuned cavity should sit away from every 1/2 revolution line since $Q_H \sim 0.5$. There is bunch-by-bunch feedback to cure CBI.

  For Akai San calculation, he estimates a phase error of 0.2 deg but perhaps this is a factor of two smaller from Ohmi San's simulation. Nevertheless, the cavities in the phase lock loop are < 0.1 deg, so no problem there. For slow phase changes, due to temo drifts etc.. the continuous closed orbit feedback should be able to tell phase drift and will be corrected by the low level phase shifter. For fast errors, the internal feedback loop between the RF reference and the cavity pickup phase can take care of this. For abnormal phase changes, it is not possible for the feedback loops to take care, therfore a recovery system is needed which is almost automatic by now.

  Akai San also did some calculations of phase modulation in a bunch train due to abort gap. The relative displacement is compensated but

there is some residual displacement between the head and the tail of the bunch train and is anticipated to be tolerable.

For th hardware, two new crab stations have been built and two high power klystrons and controller have been insatlled which are similar to the existing four high power stations for SC cavities. Attached to the power source is a 1MW circulator and dummy load. The RF controls is analog and mostly similar to the SC cavities. The cavity tuning system is made of piezo and steper motor in series which later the horizontal position of the coax coupler for frequency adjustement and also a horizontal movement setup to avoid crab mode coupling into HIM damper.

Akai San explained the low level RF controls (Slide 17 in his presentation). The input RF reference signal goes through a variety of components which are all in sequence on the upper left panel on the analog controls in D11. This signal goes to the klystron, circulator and the cavity (black line). The pickup signal from the cavity is fed back into amplitude and phase lock loop which are then connected to a feedback system and the reference signal is modified accordingly to control the amplitude and phase to the desired level (< 0.1deg). There is a separate tuning loop for slow tuning (red lines to the right), which use the pickup signal and control the piezo and stepper motor to alter the position of the coax coupler.

During operation, pilot power is sent to the cavity and frequency and phase search is initiated just using the klystron loop. Once, this is achieved, they close the amplitude and phase loop and gradually increase the power to the cavity. The LER cavity has been siginificantly worse as stated in the previous part of the log ($\pm$15deg) w/o the phase lock loop as compared to $\pm$2 deg for the HER cavity which is most likely due to the coax coupler.

Yamamoto San also presented in the 9am meetings of correlation between the crab cavities trip and its compenents and most of the trips point to the input coupler in the LER with a few that are due to the coax. Hosoyama San feels that the real source is unknown and perhaps there is a CO layer in the LER cavity from the HOM outgasing which points to the high pressure they observe during normal running. A possible hydrogen layer sticking to this CO layer can make the thermal conductivity poor and hence the temp. higher for the LER cavity (5.2 K vs. 4.8 K for HER). His solution is to warm up the cavity to remove this CO layer and recondition it.

- **Feb 28, 2007 (Wednesday)**: Most of last night shift was used to increase the current with the multibunch mode and during the night they tried to increase the single bunch current and collision tuning. The plan for most of day is to increase the multibunch current gradually ($\sim$1mA/hr). Toward the evening, they want increase the single bunch current to 1.4/1.2 mA for HER/LER respectively. Perhaps some cavity

conditioning is needed but not clear when they will perform this. For now only beam conditioning.

Ohmi San mentioned that if the single bunch current increase is not very successful, we can try the tune scan to find a better working point. The system they have here is to measure the beam response to coherent kick spanned in frequency (BTF type) where all the bunches are excited. The other way is to use the pilot bunch (no collisions) to kick and measure the FFT spectrum to get working point.

Oide San mentioned that the asymmetry from the horizontal offset scan perhaps did not have the full range, and maybe can't conclude anything. There was a measurement last night with the ibump where the beam-beam kick force calculated from the orbit. It appears like the bb kick as a function of horizontal offset has shrunk in size which points to a small horizontal size. Perhaps they can use the Belle vertex detector to verify the profile at the interaction point but some hardware problems at the end of Belle.

6:30pm and they are upto 135mA in each ring. They will go upto 140mA and then try to increase bunch intensity but with fewer bunches. Collision tuning will follow with the fewer bunches. Reached their target of 140mA in both rings.

- **Mar 1, 2007 (Thursday)**:

  Last night scan using 30 mA/30 bunches were done and it was found that the reduced beam-beam profile was not real. The closed orbit feedback system of the crab cavities has some abnormal parameters which was causing residual orbit due to the IP scan and then followed by correction by the feedback system. Another scan after proper parameters show a normal profile.

  Some more details on iBump scans: Typically they use about 12 dipole correctors in the IP to correct position and angle. The HER beam is scanned. The intial scan is done over a wide range to approx find a smaller optimum range (either σ_y or beam-beam kick). Prior to crabbing, the vertical beam size of the e^+ was set at some optimum level to reduce blow up and used as a scanning observable. Now the beam-beam kick from the bump is used to locate the center, but like previosu days, the lifetime is better when the beams are put slightly offset (horizontal) from the center.

  For IP η_y and x/y coupling, they have 4 pairs of sextupoles on each side of the IP to make asymmetric bumps as mentioned before. They construct three so called "knobs" and each knobs use the IR magnets to correct R matrix, dispersion, chromaticity, etc.. Knob three uses all sextupoles in the machine instead of just IP sextupoles. Typically they monitor luminosity, lifetime, and beam size as a function of these knobs and ... San mentioned that these knobs have helped them increase the

average luminosity by about 30-40in luminosity maybe much smaller in hadron colliders with round beams with such knobs. However, all tuning is done with few bunches due to big losses at high current.

Discussion with Tejima San: The method is very simple. Four electrodes per BPM measuring 4 voltage signals to calculate the X/Y position. Only 3 electrodes are sufficient to make a measurement, so use 3 combinations of 3 electrodes to check that they are "consistent" with each other. This is continuous measurement and they have a display that measures the standard deviation of the 3 combinations and flags if stdev > threshold.

For BPM gain mapping: they have a model based on a 4th order polynomial and they use two dipole correctors ($\pi/2$ in phase advance) to create several closed orbits X and/or Y. They measure the voltage from the 4 electrodes to make a four vector for all the different closed orbits (position pattern is like a diamond grid). Number of closed orbits > 4 to make an overdetermined system and solve for the least squares to fit data and model (fit parameter is gain). They typically do such a mapping everytime they shutdown and startup or when the BPM gains show a large inconsistency from the measurements. I guess one could argue about the model, but given some configuration of the bpm plates/buttons, one could calculate the response of the BPM using some finite element code if you want to get really sophisticated. But the 4th order polynomial seems to be working pretty good.

Most of the day was spent trying to increase the current with multibunch upto 180 mA in both rings.

- **Mar 2, 2007 (Friday)**:

  Sumamry of the previous day was discussed in the 9am meeting. Akai San presented some data on crab cavity trips during the current increase for the past couple of days. Data seems pretty reasonable and the cavities seems pretty stable. There was a long discussion about Koiso San's plot of the specific luminosity vs. beam current. The trend from the previous days at very low currents doesn't look very promising as far as the increase in the luminosity. However, the luminosity monitors are not very reliable at such low currents and the comparison to the high current case maybe a little misleading. Also, the β^* are different to compensate for the change in crab voltage in both rings, so simulations are needed to make a comparison a more accurate comparison of the performance with crab cavities on.

  Lunch with Akai San: He explained me a few things from the meeting this morning. Basically they have operated these last couple of weeks:

  - 30 + 1 pilot bunches ($\sim$30 mA), collision tuning
  - $\sim$1400 bunches ($\sim$200 mA)

  Since, the luminosity scope is not very accurate at these low currents, they will try to increase the number of bunches to 50 (and maybe 100), and

also increase the bunch current to >1 mA. If the crab cavities are stable, then go even higher. The next milestone would be to reach 200 bunches with ∼250 mA which will yield a significant beam-beam tune shift.

If crab cavities start to trip a lot, they may discuss to either warm up the cavities to de-gas and probably apply more conditioning. Also, increasing the LER voltage may help to reduce the β^* and recover any loss (which is estimated to be not significant). If the cavities are wildly unstable due to some HOM or vacuum thresholds, they may decide to remove them from the ring. However, from the previous weeks, the cavities appear pretty stable and likely to get better with higher current conditioning.